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CORE-ATTACHED RIM WHEEL AND TIRE/RIM WHEEL ASSEMBLY

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CORE-ATTACHED RIM WHEEL AND TIRE/RIM WHEEL ASSEMBLY

[Nakakotsuki rimu hoiru oyobi taiya · rimu hoiru kumitachitai]

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[There are no amendments to this patent.]

Claims /2*

1. A type of core-attached rim wheel characterized by the following facts: the core-attached rim wheel has a rim wheel having a pair of rim flange portions and a core set in the outer peripheral portion of said rim wheel;

* [Numbers in the margin indicate pagination in the foreign text.]

the rim wheel has a first rim wheel structural member having one rim flange portion, a second rim wheel structural member that can be divided in the axial direction from said first rim wheel structural member and that has the other rim flange portion,

a core, which is installed in a ring shape on the rim outer peripheral portion of at least one of said first rim wheel and said second rim wheel by connecting plural core pieces that can be inserted from between the beads of the tire, and which has plural secondary air chambers discontinuous in the circumferential direction from the rim outer peripheral portion of at least one of said first rim wheel and said second rim wheel,

and connecting portions that connect said secondary air chambers to the tire air chamber formed between the tire inner surface and the rim wheel;

and said secondary air chambers and said connecting portions work as a Holtz resonance sound absorber.

2. The core-attached rim wheel described in Claim 1 characterized by the fact that said core has plural partition walls that divide said secondary air chambers.

3. The core-attached rim wheel described in Claim 1 or 2 characterized by the fact that the resonance frequency of the Holtz resonance sound absorber composed of said secondary air chambers and said connecting portions is set in the range of 100-500 Hz.

4. The core-attached rim wheel described in any of Claims 1-3 characterized by the fact that the total volume of said secondary air chambers with respect to the tire air chamber total volume including said tire air chamber and said secondary air chambers is in the range of 2-50%.

5. The core-attached rim wheel described in any of Claims 1-4 characterized by the fact that there are connecting means for connecting core pieces at the end portions in the circumferential direction of said core pieces.

6. The core-attached rim wheel described in Claim 5 characterized by the fact that the connecting means has recessions or holes opening in the radial direction and protrusions that protrude in the radial direction and are engaged in said recessions or holes.

7. The core-attached rim wheel described in any of Claims 1-6 characterized by the fact that in the rectangular cross-section in the circumferential direction of said core, the axial direction width of the inner portion in the radial direction is larger than the axial direction width of the outer portion in the radial direction.

8. The core-attached rim wheel described in any of Claims 1-7 characterized by the fact that a portion of said core is set on the inner side in the radial direction of the bead portion of the installed tire.

9. The core-attached rim wheel described in any of Claims 1-8 characterized by the fact that an elastic material layer is set on the outer peripheral surface of said core.

10. The core-attached rim wheel described in any of Claims 1-9 characterized by the fact that a sound absorbing material is included in said secondary air chambers.

11. The core-attached rim wheel described in any of Claims 1-10 characterized by the fact that said connecting portion contains a valve with its opening area changeable electrically.

12. The core-attached rim wheel described in Claim 11 characterized by the fact that said valve is controlled based on the result of detection of vibration of a vibration detecting sensor set onboard the vehicle.

13. The core-attached rim wheel described in any of Claims 1-12 characterized by the fact that it has a rotation inhibiting means that inhibits relative rotation between said core and said rim wheel.

14. A type of tire/rim wheel assembly characterized by the following facts:

the tire/rim wheel assembly is prepared by assembling a tire on the core-attached rim wheel described in any of Claims 1-13;

the radial direction distance from the rim wheel bead sheet to the outermost surface of said core in the radial direction is 30-70% of the radial direction distance from the rim wheel bead sheet to the inner surface of the tire tread portion.

<u>Detailed explanation of the invention</u>

[0001]

Technical field of the present invention

The present invention pertains to a type of core-attached rim wheel for a vehicle having tires attached on it and a type of tire/rim wheel assembly prepared by installing a tire on said core-attached rim wheel. More specifically, the present invention pertains to a type of core-attached rim wheel and a type of tire/rim wheel assembly that can ensure high steering stability while suppressing vibration transferred to the vehicle, can improve the riding comfort and can reduce the noise in the vehicle chamber.

[0002]

Prior art

In recent years, in order to guarantee safety in case of tire puncture, technology for a load supporting body known as a run-flat tire or core has been developed.

[0003]

For a run-flat tire, as described in Japanese Kokai Patent Application No. Hei 5[1993]-229316, a type of tire having reinforcing rubber with a crescent cross-section set in the side portion is now commercially available.

[0004]

For the core, as described in Japanese Kokai Patent Application No. Hei 2[1990]-246811, an assembly is set in the well portion of the rim.

[0005]

In both said schemes, although the running distance can be prolonged in case of puncture, for the side reinforced tire, due to an increase in weight caused by the reinforcing rubber and the height in the longitudinal springs, the comfort deteriorates. The core also increases the weight and leads to deterioration in comfort. This is undesired.

[0006]

Consequently, although safety in case of a puncture can be improved, in the case of running with conventional internal pressure, finally, it is unfavorable to the driver, and this hampers popularization of the run-flat tire.

[0007]

On the other hand, as a technology to overcome the disadvantage pertaining to the riding comfort of the core, a type of wheel with a supporting portion having air chambers is disclosed in Japanese Kokai Patent Application No. Hei 1[1989]-314612. /3

[0008]

The air chambers in said supporting portion and the tire air chamber are connected by means of connecting portions having directional elements set there. When an impact force is applied due to change in volume of the tire, due to the resistance in the connecting portions, the impact is damped.

[0009]

Also, in Japanese Kokai Patent Application No. Hei 7[1995]-17222, a technology is disclosed wherein a porous substance or fibrous substance is installed in the core assembly to suppress the tire internal capacity resonance sound so as to reduce noise inside the vehicle.

[0010]

Problems to be solved by the invention

Among said prior art measures, for the rim wheel disclosed in Japanese Kokai Patent Application No. Hei 1[1989]-314612, because a supporting part with a diameter larger than the

bead sheet portion has a structure integrated to the rim portion, the tire bead essentially cannot be assembled on the rim over the supporting portion. This is a fatal disadvantage.

[0011]

On the other hand, for the rim wheel disclosed in Japanese Kokai Patent Application No. Hei 7[1995]-17222, although the cavity resonance sound can be suppressed to a certain degree, the improvement effect is nevertheless insufficient, and this is undesired.

[0012]

In addition, in order to install the porous substance or fibrous substance such that it is not separated when the vehicle is running, or when the rim is assembled, the manufacturing operation requires a large number of manufacturing man-hours, and this is undesired for industrial production.

[0013]

The objective of the present invention is to solve the aforementioned problems of the prior art by providing a type of core-attached rim wheel and a type of tire/rim wheel assembly for practical application characterized by the fact that without sacrifice of the riding comfort and other properties, it can improve the quietness and steering stability, both major properties required for an automobile, and it can improve safety in the case of catastropic puncture.

[0014]

Means to solve the problems

The invention described in Claim 1 provides a type of core-attached rim wheel characterized by the following facts: the core-attached rim wheel has a rim wheel having a pair of rim flange portions and a core set in the outer peripheral portion of said rim wheel; the rim wheel has a first rim wheel structural member having one rim flange portion, a second rim wheel structural member that can be divided in the axial direction from said first rim wheel structural member and that has the other rim flange portion, a core, which is installed in a ring shape on the rim outer peripheral portion of at least one of said first rim wheel and said second rim wheel by connecting plural core pieces that can be inserted from between the beads of the tire, and which has plural secondary air chambers discontinuous in the circumferential direction from the rim outer peripheral portion of at least one of said first rim wheel and said second rim wheel, and connecting portions that connect said secondary air chambers to the tire air chamber formed between the tire inner surface and the rim wheel; and said secondary air chambers and said connecting portions work as a Holtz resonance sound absorber.

[0015]

In the following, an explanation will be given regarding the operation of the core-attached rim wheel described in Claim 1.

[0016]

According to the present invention, the rim wheel has a first rim wheel structural member having one rim flange portion, a second rim wheel structural member that can be divided in the axial direction from said first rim wheel structural member and that has the other rim flange portion. As a result, when the core is inserted beforehand into the tire, it is assembled on the outer peripheral surface of the first rim wheel structural member, and finally the second rim wheel structural member is connected to the first rim wheel structural member. In this way, it is possible to assemble the tire on the rim.

[0017]

Also, in some cases, the following scheme may be adopted: the core is inserted beforehand in the tire, it is assembled on the outer peripheral surface of the second rim wheel structural member, and, finally, the first rim wheel structural member is connected to the second rim wheel structural member.

[0018]

However, in order to suppress tire deflection that has a major influence on the tire durability in case of tire puncture, the core has to have a certain height.

[0019]

However, in a conventional tire rim assembly operation, it is very difficult to insert a core with a large height into the tire.

[0020]

As explained above, according to the present invention, after the core is inserted beforehand in the tire, it is assembled on the first rim wheel structural member or the second rim wheel structural member. However, in order to insert a core with a larger outer periphery into the tire, it is preferred that the core be divided.

[0021]

That is, for insertion of a part with a circumference longer than the circumferential length of the tire bead into the tire, there is a certain limit. When the core is formed as a monolithic ring, only a core with a circumferential length similar to the outer peripheral length of a conventional rim flange can be inserted into the tire.

[0022]

Consequently, when a core with a larger outer periphery is to be inserted into a tire, the core is formed in a divided type composed of plural core pieces, and after the core pieces are inserted into the tire, a connecting means is used to form a ring.

[0023]

As explained above, in order to inhibit backlash, it is preferred that the circumferential length of the inner peripheral portion of the ring-shaped core after connection be equal to the circumferential length of the outer peripheral portion of the adjoined rim wheel.

[0024]

There is no specific restriction on the connecting mechanism. For example, one may adopt a method of fixing using bolts, screws, etc., a method using parting bolts or another connecting mechanism, or a method of fastening using a highly elastic band.

[0025]

By adopting a core-attached rim wheel with said constitution, it is possible to assemble a tire rim easily without using a conventional tire changer, and the design freedom of the core can also be improved.

[0026]

Here, when the core is set in the rim outer peripheral portion of a rim wheel that can be formed by connecting the first rim wheel structural member and the second rim wheel structural member, plural discontinuous secondary air chambers in the circumferential direction are /4
formed from at least one rim outer peripheral portion of the first rim wheel and the second rim wheel.

[0027]

The secondary air chambers and the connecting portions work as a Helmholtz resonance sound absorber.

[0028]

For sound at a prescribed frequency to be suppressed, by selecting an appropriate volume for the secondary air chambers, the cross-sectional area and length of the connecting portions, etc., it is possible to display a resonance sound absorbing effect by means of the secondary air chambers.

[0029]

When the secondary air chamber is a continuous one in the circumferential direction, not only can the Helmholtz resonance sound absorber function not be displayed, but also a new cavity resonance takes place inside the secondary air chamber, and a sound reducing effect cannot be displayed. According to the present invention, the secondary air chamber is formed in a discontinuous way in the circumferential direction, so that the aforementioned problem can be solved. Also, because the internal secondary air chambers cannot be formed in a ring shape, each core piece may have a partition wall on the end portion in the circumferential direction on one side or on both sides.

[0030]

Also, for the tire of a sedan, a peak exists near 250 Hz that is believed to be cavity resonance, and this is one of the noises inside the vehicle. However, by setting said element appropriately, it is possible to significantly reduce the cavity resonance sound.

[0031]

Also, according to the constitution of the present invention, the property in damping vibration caused by input to the tire can be significantly improved.

[0032]

In order to realize the function of a Helmholtz resonance sound absorber, the cross-sectional area of the connecting portion of said core is set relatively small, so that resistance develops for the flow of air between the tire air chamber and the secondary air chambers in case of tire deformation. Consequently, it is possible to improve the damping property for vibration caused by tire deformation. For example, it is possible to improve the damping property for vibration that takes place when the vehicle goes on bumps on the road. Also, for high frequency input in case of rapid manipulation of the steering wheel and high speed running, the apparent tire dynamic spring constant rises, and the steering stability can be improved.

[0033]

Also, in order to avoid backlash of the core during conventional running, it is preferred that the circumferential length of the core be equal to the circumferential length of the adjoined rim wheel. Also, it is preferred that the core be fixed on the rim wheel such that the two ends of the core in the axial direction are sandwiched by the rim wheels.

[0034]

In addition, as needed, one may set rubber, foam plastic material or another buffer elastic material on the joint plane between the core and the rim wheel.

[0035]

Also, although there is no specific restriction on the material of the rim wheel, it is preferred that it be made of a conventionally used material of iron, aluminum, magnesium, etc.

[0036]

There is no specific restriction an the material of the core. However, in consideration of the requirement for the support of load and impact from the road surface in case of puncture, it is preferably made of iron, aluminum, magnesium or another metal material, as well as from fiber-reinforced resin composite material, engineering plastics, and other high strength materials.

[0037]

Also, in order to suppress the frictional heat between the tire inner surface and the core in case of puncture, it is preferred that silicone oil or another lubricant be coated on the surface of the core or the inner surface of the tire.

[0038]

The invention described in Claim 2 pertains to the core-attached rim wheel described in Claim 1 characterized by the fact that said core has plural partition walls that divide said secondary air chambers.

[0039]

In the following, an explanation will be given regarding the operation of the core-attached rim wheel described in Claim 2.

[0040]

As explained above, if a secondary air chamber is formed continuously in the circumferential direction, it cannot work as a Helmholtz resonance sound absorber, and it cannot reduce the cavity resonance sound. Consequently, the secondary air chamber should be formed discontinuously in the circumferential direction. For this purpose, it is important to set partition walls in the core beforehand. For said partition walls, although there is no need to have a strict airtight property between the various secondary air chambers, it is preferred that they be set with no gap if possible so as to display an even better sound reducing effect.

[0041]

Also, by setting plural partition walls to form plural secondary air chambers, it is possible to realize general purpose application. Consequently, this is an important measure.

[0042]

For a prescribed rim size, several cases of installation of tires of different sizes (height) have been assumed. The frequency of the cavity resonance sound depends on the inner periphery of the tire tread portion and the outer periphery of the rim, and, for the same rim, when the height (flatness) of the tire attached on it is changed, the frequency of the cavity resonance sound changes.

[0043]

When plural secondary air chambers are prepared, it is possible to change the dimensions of said connecting portions and the volume of the air chambers so that the resonance frequency is shifted. As a result, it is possible to realize general purpose application.

[0044]

It is preferred that the resonance frequencies of the secondary air chambers be in the range of 10-30 Hz.

[0045]

There is no specific restriction on the number of secondary air chambers. However, usually, three or more are preferred. Also, it is preferred that the partitions be distributed evenly on the circumference in consideration of the rotating balance.

[0046]

Also, even if a certain tire size is selected, under the load condition, etc., the frequency may vary, and the peak can become wider or become split into two peaks. In consideration of this feature, it is preferred that plural secondary air chambers be set and their resonance frequencies deviate from one another.

[0047]

The invention described in Claim 3 pertains to the core-attached rim wheel described in Claim 1 or 2 characterized by the fact that the resonance frequency of the Helmholtz resonance sound absorber composed of said secondary air chambers and said connecting portions is set in the range of 100-500 Hz.

[0048]

In the following, an explanation will be given regarding the operation of the core-attached rim wheel described in Claim 3.

[0049]

The cavity resonance frequency in the tire air chamber depends on the circumferential /5
length of the tire and that of the rim. For the smaller tires of compact automobiles, the frequency is higher, while for the larger tires for trucks, the frequency is lower. According to studies performed by the present inventors on tires for conventional sedans at a cavity resonance frequency of 250 Hz, it was found that when the setting is in the range of 100-500 Hz, a cavity resonance sound reduction effect can definitely be realized. Consequently, in the closed space of the tire, a relatively wide range can be set as aforementioned.

[0050]

According to the constitution of current tire sizes, the resonance frequencies of the various tires are approximately in the range of 180-300 Hz. By adjusting the various dimensions to ensure that the frequency set for the Helmholtz resonance sound absorber is also within said range, a higher sound reducing effect can be realized, and this is preferred.

[0051]

Also, the resonance frequency of the Helmholtz resonance sound absorber composed of said secondary air chambers and connecting portions can be determined using following formula (1).

[0052]

Mathmatical Formula 1

$$f_0 = 5410 \times \sqrt{\frac{Sn}{Vn\,(Ln + 0.8\sqrt{Sn})}} \cdots\cdots (1)$$

[0053]

f_0(Hz): resonance frequency

Vn (cm^3): volume of the secondary air chambers

Ln (cm): length of the connecting portions

Sn (cm^2): cross-sectional area of the connecting portions

Here, n represents the number of secondary air chambers when there are plural secondary air chambers.

[0054]

Also, when there are a plurality (i) of connecting portions for each secondary air chamber, assuming that the cross-sectional area of each connecting portion is Si and its length is Li, one can compute as follows:

$$Sn = \Sigma Si \ (i = 2 \sim i)$$
$$Ln = \Sigma Si \cdot \quad Li / \Sigma Si$$

[0055]

The invention described in Claim 4 pertains to the core-attached rim wheel described in any of Claims 1-3 characterized by the fact that the total volume of said secondary air chambers with respect to the tire air chamber total volume including said tire air chamber and said secondary air chambers is in the range of 2-50%.

[0056]

In the following, an explanation will be given regarding the operation of the core-attached rim wheel described in Claim 4.

[0057]

If the total volume of the secondary air chambers is less than 2% of the total volume of the tire air chamber including both the tire air chamber and the secondary air chambers, the effect in improving the steering stability and in reducing the cavity resonance sound is insignificant.

[0058]

On the other hand, if the total volume of the secondary air chambers is over 50% of the total tire air chamber volume including the tire air chamber and the secondary air chambers, the spring constant is too high with respect to the high frequency input, and this is also undesirable.

[0059]

It is even more preferred that the total volume of the secondary air chambers be 10-40% of the total tire air chamber volume including the tire air chamber and the secondary air chambers.

[0060]

The invention described in Claim 5 pertains to the core-attached rim wheel described in any of Claims 1-4 characterized by the fact that there are connecting means for connecting core pieces at the end portions in the circumferential direction of said core pieces.

[0061]

In the following, an explanation will be given regarding the operation of the core-attached rim wheel described in Claim 5.

[0062]

Because the connecting means for connecting the core pieces is set at the end portion in the circumferential direction of the core piece, it is possible to connect the core pieces without a need for separated bolts or other connecting members.

[0063]

The invention described in Claim 6 pertains to the core-attached rim wheel described in Claim 5 characterized by the fact that the connecting means has recessions or holes opening in the radial direction and protrusions that protrude in the radial direction and are engaged in said recessions or holes.

[0064]

In the following, an explanation will be given regarding the core-attached rim wheel described in Claim 6.

[0065]

For example, by forming a recess or hole on one end side of a core piece and forming a protrusion on the other end side, when the recess or hole of one core piece is engaged to the protrusion of said another core piece, it is possible to connect the core pieces easily in the circumferential direction. Also, when the connecting means is composed of holes and protrusions, the structure is simple and the manufacturing cost can be cut.

[0066]

The invention described in Claim 7 pertains to the core-attached rim wheel described in any of Claims 1-6 characterized by the fact that in the rectangular cross-section in the circumferential direction of said core, the axial direction width of the inner portion in the radial direction is larger than the axial direction width of the outer portion in the radial direction.

[0067]

In the following, an explanation will be given regarding the operation of the core-attached rim wheel described in Claim 7.

[0068]

For the core, it is important to ensure that in case of tire puncture, it is possible to suppress deflection of the tire, to support the load, and to have durability to run for a prescribed distance.

[0069]

Also, it should have a high resistance to damage against impact applied during running in case of tire puncture.

[0070]

Consequently, for the core, it is necessary to ensure that the stress applied on the core is dispersed instead of concentrated at one site. As a result, it is preferred that for the rectangular cross-section of the outer peripheral surface of the core, the curved surface have a curvature as small as possible.

[0071]

When the area of contact between the core and inner surface of the tire tread in case of tire puncture is decreased, the contact pressure with the contact surface is increased, so that heating and wear of the inner surface of the tread are accelerated, and this is undesired.

[0072]

Consequently, for the rectangular cross-section in the circumferential direction of the core, since the outer peripheral portion is either flat or has a large curvature like the tread of the tire, and the portion corresponding to the so-called shoulder-side portion of the tire has a large curvature (for stress dispersion), it is preferred that the axial direction width of the inner portion /6 in the radial direction be larger to form a tailing shape.

[0073]

The invention described in Claim 8 pertains to the core-attached rim wheel described in any of Claims 1-7 characterized by the fact that a portion of said core is set on the inner side in the radial direction of the bead portion of the installed tire.

[0074]

In the following, an explanation will be given regarding the operation of the core-attached rim wheel described in Claim 8.

[0075]

By setting a portion of the core on the inner side in the radial direction of the bead portion of the installed tire, it is possible to fix the core by means of the bead portion of the tire.

[0076]

Also, when the core is composed of plural core pieces, even if the connecting portions of the core pieces fall off as the vehicle runs normally under conventional internal pressure or in case of tire puncture, because the core is fixed by means of the bead portion, it is still possible to avoid failure of running of the vehicle.

[0077]

Also, it is preferred that a portion of the core be set on the inner side in the radial direction of the tire bead portions on the two sides.

[0078]

The invention described in Claim 9 pertains to the core-attached rim wheel described in any of Claims 1-8 characterized by the fact that an elastic material layer is set on the outer peripheral surface of said core.

[0079]

In the following, an explanation will be given regarding the operation of the core-attached rim wheel described in Claim 9.

[0080]

According to the present invention, because the elastic material layer formed on the outer peripheral surface of the core can absorb vibration from the road surface, it is possible to improve the riding comfort while the vehicle runs in case of tire puncture.

[0081]

Also, since the elastic material layer can buffer impact in case of tire puncture, it is possible to improve the resistance of the core to damage.

[0082]

Also, in case of tire puncture, the elastic material layer supports the load, and while running heat is generated due to friction with the inner surface of the tread. As a result, in order to disperse the stress and the improve the heat dissipation property, slots may be formed in the elastic material layer just like the tire tread as needed.

[0083]

There is no specific restriction on the type of elastic material. Usually, one may use rubber, synthetic resins, foaming materials (such as sponge), etc. For the method for bonding with the core, one may adopt a scheme of bonding, vulcanization bonding, or another scheme.

[0084]

The invention described in Claim 10 pertains to the core-attached rim wheel described in any of Claims 1-9 characterized by the fact that a sound absorbing material is included in said secondary air chambers.

[0085]

In the following, an explanation will be given regarding the operation of the core-attached rim wheel described in Claim 10.

[0086]

When a sound suppressing material (sound absorbing material) is included in the secondary air chambers, it is possible to further improve the sound suppressing effect of the secondary air chambers.

[0087]

There is no specific restriction on the material of the sound absorbing material. For example, one may use a cotton-like substance or a foam-like material.

[0088]

The invention described in Claim 11 pertains to the core-attached rim wheel described in any of Claims 1-10 characterized by the fact that said connecting portion contains a valve with its opening area changeable electrically.

[0089]

In the following, an explanation will be given regarding the operation of the core-attached rim wheel described in Claim 11.

[0090]

By setting a valve that can adjust its opening area electrically at each connecting portion, for example, it is possible to change the passing resistance for the internal air by means of an onboard computer in the vehicle, so that it is possible to change the vibration absorbing characteristics at a high response speed.

[0091]

As a result, it is possible to change the opening area automatically to minimize vibration and noise in the vehicle chamber.

[0092]

The invention described in Claim 12 pertains to the core-attached rim wheel described in Claim 11 characterized by the fact that said valve is controlled based on the result of detection of the vibration of vibration detecting sensor set onboard the vehicle.

[0093]

In the following, an explanation will be given regarding the operation of the core-attached rim wheel described in Claim 12.

[0094]

For example, when a large-amplitude vibration due to a high input or the like is detected with the vibration detecting sensor, the opening area can be increased to reduce the spring constant so as to relax the impact and to improve the riding comfort.

[0095]

Here, the position for installing the vibration detecting sensor may be at any location where detection of vibration is possible. Usually, it is preferred that the vibration be detected at the lower portion of the spring of the suspension because it is near the road surface.

[0096]

The invention described in Claim 13 pertains to the core-attached rim wheel described in any of Claims 1-12 characterized by the fact that it has a rotation inhibiting means that inhibits relative rotation between said core and said rim wheel.

[0097]

In the following, an explanation will be given regarding the operation of the core-attached rim wheel described in Claim 13.

[0098]

Because the rotation inhibiting means prevents relative rotation between the core and the rim wheel, it is possible to improve the transmission property of a front/rear force during running in case of tire puncture, and it is possible to suppress torsional deformation in the circumferential direction of the tire. As a result, it is possible to increase the running distance after tire puncture.

[0099]

The invention described in Claim 14 pertains to a type of tire/rim wheel assembly characterized by the following facts: the tire/rim wheel assembly is prepared by assembling a tire on the core-attached rim wheel described in any of Claims 1-13; the radial direction distance from the rim wheel bead sheet to the outermost surface of said core in the radial direction is 30-70% of the radial direction distance from the rim wheel bead sheet to the inner surface of the tire tread portion.

[0100]

In the following, an explanation will be given regarding the operation of the tire/rim wheel assembly described in Claim 14.

[0101]

If the distance from the rim wheel bead sheet portion to the outermost surface of the core in the rim radial direction, that is, the height of the core is less than 30% of the distance from /7 the rim wheel bead sheet portion to the inner surface of the tire tread portion, crush deformation of the tire in case of tire puncture becomes very serious, and the tire durability deteriorates. As a result, the distance of running after tire puncture is decreased, and this is undesired.

[0102]

On the other hand, if the distance from the rim wheel bead sheet portion to the outermost surface of the core in the rim radial direction, that is, the height of the core, is more than 70% of the distance from the rim wheel bead sheet portion to the inner surface of the tire tread portion, in the normal running state with sufficient internal pressure, when the vehicle runs over a bump, the tire and the core contact each other, leading to abnormal vibration. This is undesired. Also, this may lead to damage of the core.

[0103]

Depending on the tire size, the radial direction distance from the rim wheel bead sheet to the core is preferably in the range of 40-60% of the radial direction distance from the rim wheel bead sheet portion to the inner surface of the tire tread portion.

[0104]

Embodiments of the present invention

<u>Embodiment 1</u>

In the following, an explanation will be given regarding Embodiment 1 of the tire/rim wheel assembly of the present invention with reference to Figures 1-4.

[0105]

As shown in Figure 1, tire/rim wheel assembly (10) in this embodiment is for a sedan, and tire (14) is assembled on core-attached rim wheel (12).

[0106]

Said core-attached rim wheel (12) is composed of first rim wheel structural member (16), second rim wheel structural member (18), and core (20).

[0107]

Just like conventional rim wheels, said first rim wheel structural member (16) and second rim wheel structural member (18) are also made of iron, aluminum, magnesium, or another metal.

[0108]

Said first rim wheel structural member (16) has cylindrical portion (24) extending to the inner side of the vehicle (the direction indicated by arrow IN) set monolithically on the outer peripheral portion of wheel disk (22).

[0109]

On the end portion of cylindrical portion (24) on the vehicle inner side, one bead sheet portion (26), which has one bead portion (14A) of tire (14) installed on it, and rim flange (28) are set monolithically.

[0110]

As shown in Figure 2, on the end portion of the vehicle outer side of cylindrical portion (24), ring-shaped recess (30) is formed. On side surface (30A) of ring-shaped recess (30), ring-shaped O-ring slot (32) and ring-shaped O-ring slot (34) are formed.

[0111]

Also, O-ring (36) is fit in O-ring slot (32), and O-ring (38) is fit in O-ring slot (34).

[0112]

Also, on side surface (30A), plural bolt holes (40) that are not through holes are formed between O-ring slot (32) and O-ring slot (34).

[0113]

Said second rim wheel structural member (18) is inserted from the vehicle outer side in ring-shaped recess (30) formed on the end portion of the vehicle outer side of cylindrical portion (24).

[0114]

Said second rim wheel structural member (18) is assembled with cylindrical portion (24) to form rim (21).

[0115]

In second rim wheel structural member (18), there are the following parts: other rim flange (42), other bead sheet portion (44) with other bead portion (14B) of tire (14) installed on it, and thick-wall outer wall portion (46) set on the inner side in the rim radial direction of bead sheet portion (44).

[0116]

On said outer wall portion (46), bolt through holes (48) are formed at the position facing said bolt holes (40).

[0117]

Bolts (50) are inserted in bolt through holes (48), and, when said bolts (50) are screwed in bolt holes (40), second rim wheel structural member (18) is fixed on first rim wheel structural member (16).

[0118]

When second rim wheel structural member (18) is fixed on first rim wheel structural member (16), outer wall portion (46) of second rim wheel structural member (18) comes in tight contact with ring-shaped recess (30) of first rim wheel structural member (16), and, when O-ring (36) and O-ring (38) are compressed, the portion between outer wall portion (46) and ring-shaped recess (30) is sealed.

[0119]

As shown in Figure 1, on the outer peripheral surface of cylindrical portion (24), the vehicle outer portion of bead sheet portion (26) is taken as core attachment surface (31) with a prescribed diameter, and core attachment surface (31) is positioned on the inner side in the radial direction with respect to bead sheet portion (26).

[0120]

Also, core attachment surface (31) is positioned on the inner side in the radial direction with respect to bead sheet portion (44) of second rim wheel structural member (18).

[0121]

As shown in Figures 3(A), (B), core (20) is set on said core attachment surface (31).

[0122]

As shown in Figures 3(A), (B), core (20) in this embodiment is composed of four core pieces (52).

[0123]

Each of core pieces (52) is a box in a quarter circular arc shape with the inner side in the radial direction open. Axial direction width W_1 of the inner peripheral portion is larger than axial direction width W_2 of the outer peripheral portion, and, as shown in Figure 1, the rectangular cross-sectional view in the circumferential direction has a trapezoidal shape.

[0124]

In order to be able to support the load, said core pieces (52) are preferably made of iron, aluminum, magnesium or other metal materials, fiber-reinforced resin composite materials, engineering plastics, and other high strength materials.

[0125]

Outer peripheral portion (52A) of each of core pieces (52) has a prescribed diameter (in the shape of a quarter of a cylinder), and it is nearly parallel to the inner surface of tread (14C) of tire (14).

[0126]

Also, outer peripheral portion (52A) and axial direction side surface portion (52B) of core piece (52) are smoothly connected to each other by arc portion (52C).

[0127]

On wall (partition wall) (52D) positioned on both sides in the circumferential direction of core piece (52), two bolt through holes (54) are formed.

[0128]

Said core pieces (52) are connected to each other to form a ring shape by bolts (56) /8
inserted in bolt through holes (54) and nuts (58) screwed onto said bolts (56).

[0129]

The inner diameter of core (20) obtained by connecting four core pieces (52) is set to be identical to the outer diameter of core attachment surface (31) of first rim wheel structural member (16).

[0130]

As shown in Figure 1, one end of core (20) in the axial direction is in contact with outer wall portion (46) of second rim wheel structural member (18), and the other end in the axial direction is in contact with the step portion formed by bead sheet portion (26) and core attachment surface (31) of first rim wheel structural member (16). As a result, movement in the axial direction is prevented.

[0131]

Also, it is preferred that radial direction distance H_1 from bead sheet portions (26), (44) to the outermost surface in the radial direction of core (20) (outer peripheral portion (52A)) be in the range of 30-70% of radial direction distance L_2 from bead sheet portions (26), (44) to the inner surface of tread (14C).

[0132]

Since box-shaped core pieces (52) are blocked by cylindrical portions (24) of first rim wheel structural member (16), secondary air chambers (60) are formed. In this embodiment, core (20) is formed from four core pieces (52), so that four secondary air chambers (60) are formed.

[0133]

Also, sealed tire air chamber (62) is formed between installed tire (14), rim (21) and core (20).

[0134]

In core pieces (52), circular connecting holes (64) connecting tire air chamber (62) and secondary air chambers (60) are formed in outer peripheral portion (52A).

[0135]

In this embodiment, secondary air chambers (60) and connecting holes (64) form a Helmholtz resonance sound absorber.

[0136]

Here, in tire/rim wheel assembly (10), it is preferred that the total volume of secondary air chambers (60) (the volume of four secondary air chambers in this embodiment) be selected in the range of 2-50%, or more preferably in the range of 10-40%, of the tire air chamber total volume including tire air chamber (62) and all of secondary air chambers (60).

[0137]

In the following, an explanation will be given regarding the procedure of assembly of tire/rim wheel assembly (10) in the present invention embodiment.

[0138]

As shown in Figure 4(A), core pieces (52) are inserted into tire (14), and, in tire (14), four core pieces (52) are connected by means of bolts (56) and nuts (58) to form ring-shaped core (20) (see Figure 3).

[0139]

Then, as shown in Figure 4(B), core (20) and tire (14) are inserted from the axial direction of first rim wheel structural member (16). Also, bead portion (14A) of tire (14) is set in bead sheet portion (26).

[0140]

Then, O-ring (36) is fit in O-ring slot (32), and O-ring (38) is fit in O-ring slot (34).

[0141]

Then, second rim wheel structural member (18) is inserted in ring-shaped recess (30) of first rim wheel structural member (16), and other bead portion (14B) of tire (14) is set in bead sheet portion (44) of second rim wheel structural member (18). Then, by means of bolts (50), second rim wheel structural member (18) is fixed to first rim wheel structural member (16).

[0142]

Then, air is pumped in through a valve (not shown in the figure).

(Operation)

In the following, an explanation will be given regarding the operation of tire/rim wheel assembly (10) in this embodiment.

[0143]

For tire/rim wheel assembly (10) of the present embodiment, when the internal pressure falls due to puncture of tire (14), the inner surface of the tread of tire (14) comes in contact with core (20), so that deflection of tire (14) is suppressed, and the load on core (20) is supported. As a result, running can be maintained.

[0144]

In the normal running state, secondary air chambers (60) and connecting holes (64) work as a Helmholtz resonance sound absorber.

[0145]

For example, in tire (14) of a sedan, a peak exists near 250 Hz that is believed to be due to cavity resonance, and this is one of the reasons for noise in the vehicle chamber. By appropriately selecting the volume of secondary air chambers (60) and the cross-sectional area, length, etc. of connecting holes (64), it is possible to significantly reduce cavity resonance.

[0146]

In the present embodiment, since secondary air chambers (60) are not continuous in the circumferential direction, no new cavity resonance takes place inside the secondary air chambers.

[0147]

In order to realize the function of a Helmholtz resonance sound absorber, the cross-sectional area of connecting holes (64) of core (20) are selected to be relatively small. As a result, when the tire is deformed, a resistance arises for gas flow between tire air chamber (62) and secondary air chambers (60), and the damping property with respect to vibration caused by tire deformation is improved. As a result, it is possible to improve the damping property for vibration generated when the vehicle runs over a bump on the road. For high frequency input in rapid manipulation of the steering wheel or high speed running or the like, the apparent tire dynamic spring constant rises, and the steering stability can be improved.

[0148]

Also, when vibration to be reduced takes place at plural frequencies (for example, when plural peaks are present in the frequency characteristics), by appropriate selection of the volume and shape of secondary air chambers (60) and the cross-sectional area and length of connecting holes (64), etc., it is possible to cope with vibration at the plural frequencies.

[0149]

In the present embodiment, each secondary air chamber (60) is connected by one connecting hole (64) to tire air chamber (62). However, one may also adopt a scheme in which two or more connecting holes (64) are adopted for this purpose.

[0150]

In this embodiment, connecting holes (64) are circular. However, other shapes different from circular can be used. As long as air can pass through, one may also adopt slits, pipes, or other tubular parts in place of connecting holes (64) to connect tire air chamber (62) and secondary air chambers (60).

[0151]

Also, pipes or other tubular parts may be attached in connecting holes (64), and, by adjusting the length and cross-sectional area of the tubular parts, it is possible to change the sound absorbing characteristics.

[0152]

Also, by filling glass wool, sponge or other cotton-like substances or foam-like /9
sound absorbents (sound absorbing material) inside secondary air chambers (60) or bonding them on the inner wall, it is possible to further improve the sound absorbing effect.

[0153]

Also, as needed, rubber, foam plastic material or another buffer elastic material may be set between core (20) and core-attached rim wheel (12).

[0154]

Also, in order to suppress frictional heat generated on the inner surface of the tire or core (20) in case of puncture, one may coat silicone oil or another lubricant on the surface of core (20) or on the inner surface of the tire.

[0155]

If radial direction distance H_1 from bead sheet portions (26), (44) to the outermost surface in the radial direction of core (20) is less than 30% of radial direction distance L_2 [sic; H_2] from bead sheet portions (26), (44) to the inner surface of tread (14C), the crush deformation of tire (14) becomes very large, and the durability of tire (14) deteriorates. As a result, the running distance after tire puncture is decreased, and this is undesired.

[0156]

On the other hand, if said radial direction distance H_1 is more than 70% of radial direction distance L_2, in the normal running mode with sufficient internal pressure, when the vehicle runs over a bump or the like, tire (14) and core (20) come in contact with each other, and abnormal vibration may be caused, and this is undesired. Also, this may lead to damage of core (20).

[0157]

Also, in this embodiment, tire/rim wheel assembly (10) is used in a sedan. Of course, the present invention may also be adopted in a tire/rim wheel assembly for use in trucks, buses, and other vehicles.

[0158]

In the case of a tire for a general purpose sedan with a cavity resonance frequency of 250 Hz, if the resonance frequency of the Helmholtz resonance sound absorber is in the range of 100-500 Hz, a cavity resonance suppressing effect is obtained. For the current structure of tire sizes, since the resonance frequency of each tire is in the range of 180-300 Hz, one can adjust the various dimensions such that the resonance frequency of the Helmholtz resonance sound absorber will also be within said range, so that a significant sound suppressing effect can be realized.

Embodiment 2

In the following, an explanation will be given regarding Embodiment 2 of the tire/rim wheel assembly of the present invention with reference to Figures 5 and 6. Here, the same part numbers as those adopted in Embodiment 1 are adopted, and they will not be explained again.

[0159]

As shown in Figures 5 and 6, in this embodiment, for core pieces (52), wall surfaces (52D) on the two ends in the circumferential direction protrude to the inner side in the radial direction, and the protruding portions of wall surfaces (52D) fit in slots (66) extending in the axial direction formed on cylindrical portion (24) of first rim wheel structural member (16).

[0160]

Consequently, the rotation of core (20) with respect to core-attached rim wheel (12) is prevented, the front/rear force transmission property is improved in case of running after tire

puncture, and it is possible to suppress torsional deformation of tire (14) in the circumferential direction, so that it is possible to prolong the running distance after puncture.

[0161]

The other operations and effects are the same as those in said Embodiment 1.

Embodiment 3

In the following, an explanation will be given regarding Embodiment 3 of the tire/rim wheel assembly of the present invention with reference to Figure 7. Also, the same part numbers as those adopted in the aforementioned embodiments are adopted here, and they will not be explained again.

[0162]

As shown in Figure 7, on the outer peripheral surface of core (20), elastic material layer (68) is set.

[0163]

Said elastic material layer (68) is made of rubber, synthetic resin, a foam material (such as sponge), or the like, and it is fixed by bonding (or vulcanization bonding for rubber) or the like.

[0164]

On elastic material layer (68), connecting holes (70) for connection to connecting holes (64) of core pieces (52) are formed.

[0165]

Also, since elastic material layer (68) is applied on the outer peripheral surface of core (20) and contacts the tread inner surface of tire (14) in case of puncture, it is possible to improve the riding comfort in case of tire puncture.

[0166]

Also, since elastic material layer (68) can buffer the impact in case of tire puncture, the resistance to damage of core (20) is improved.

[0167]

Also, slots may be formed on elastic material layer (68) to disperse the stress and to improve the heat dissipation property.

[0168]

The other operations and effects are the same as those of the aforementioned embodiments.

Embodiment 4

In the following, an explanation will be given regarding Embodiment 4 of the tire/rim wheel assembly of the present invention with reference to Figure 8. Here, the same part numbers as those adopted in the aforementioned embodiments are adopted, and they will not be explained again.

[0169]

As shown in Figure 8, in this embodiment, flange portions (52D) extending to the outer side in the inner end portion of core piece (52) are set monolithically. Said flange portions (52D) are set on the inner side in the radial direction of bead portions (14A), (14B) of tire (14).

[0170]

In this embodiment, said flange portions (52D) become bead sheet portions, and flange portions (52D) are sandwiched and fixed between bead portions (14A), (14B) of tire (14) and rim wheel (12).

[0171]

Consequently, in the normal running state with sufficient internal pressure, or during running after tire puncture, even if problems take place in the connecting portion of core pieces (52), it is still possible to avoid the state of movement of core pieces (52) and thus failure of running of the vehicle.

[0172]

The other operations and effects are the same as those in said embodiments.

Embodiment 5

In the following, an explanation will be given regarding Embodiment 5 of the tire/rim wheel assembly of the present invention with reference to Figure 9. The same part numbers as

those adopted in the aforementioned embodiments are adopted, and they will not be explained again.

[0173]

As shown in Figure 9, valve (72) that can adjust the opening area under electric control is attached on connecting hole (64) of core (20).

[0174]

Wire (74) for controlling said valve (72) is connected via slip ring (76) set between the rim wheel and the wheel shaft (not shown in the figure) to computer (78) carried on the vehicle.

[0175]

On the lower portion of the spring in the vehicle (such as in the position of the suspension where it is attached on the vehicle frame), vibration detecting sensor (80) connected to computer (78) is mounted.

[0176]

In this embodiment, because it is possible to change the opening area using valve (72), it is possible to change the vibration absorbing characteristics, and, based on the vibration detection result (frequency, amplitude, acceleration, etc.) obtained with vibration detecting sensor (80), valve (72) is controlled by computer (78) such that the noise in the vehicle chamber can be minimized.

[0177]

Also, because the passage of air can be completely stopped, as needed, it is also possible to only connect the essential secondary air chambers (60) to tire air chamber (62).

[0178]

Also, the position of vibration detecting sensor (80) may be set at a portion other than the lower portion of the spring.

[0179]

Said control may be performed not only for each individual tire, but also simultaneously for both the tires and the active suspension of the automobile. As a result, one can expect major effects in improving the riding comfort and in reducing noise inside the vehicle chamber.

[0180]

Also, the driver may turn ON/OFF valve (72) using a switch.

Embodiment 6

In the following, an explanation will be given regarding Embodiment 6 of the tire/rim wheel assembly of the present invention with reference to Figures 10 and 11.

[0181]

As shown in Figures 10 and 11, core (82) in this embodiment is composed of two half-circular arc shaped core pieces (84).

[0182]

Inside core pieces (84), two partition walls (86) are formed with a spacing from each other in the circumferential direction.

[0183]

Consequently, by core (82) of the present embodiment on the rim wheel, it is possible to form six secondary air chambers.

[0184]

Also, on core pieces (84), connecting holes (88) are formed for the secondary air chambers, respectively.

[0185]

On core pieces (84), coupling piece (92) is formed monolithically protruding in the circumferential direction from wall surface (90) on one side in the circumferential direction. On the other side in the circumferential direction of core pieces (84), recess (94) is formed for fitting with coupling piece (92).

[0186]

Plural projections (96) projecting outwards in the radial direction are formed in recess (94). Through holes (98) for insertion of projections (96) are formed on coupling piece (92).

[0187]

In this embodiment, two core pieces (84) are inserted in the tire, core pieces (84) deform, and coupling piece (92) is coupled to recess (94). As a result, ring-shaped core (82) is formed.

[0188]

Also, Figures 12 and 13 illustrate a modified example of said core (82). In the embodiment shown in Figures 12 and 13, wall surface (90) is set only on one side. As the connecting means of core pieces (84), as shown in Figure 12, on one side in the circumferential direction of core pieces (84), a recess and a protrusion having a nearly triangular cross-sectional shape are formed. On the other side, a protrusion and a recess for fitting in said recess and protrusion are formed. As shown in Figure 13, the recess and protrusion are formed in a smooth curved shape.

(Test Example 1)

In order to check the effect of the present invention, a type of tire/rim wheel assembly as a comparative example (control sample: assembly of a rim wheel and tire in the prior art) and a type of the tire/rim wheel assembly in an application example in which a divided type rim wheel and core of the present invention and tire are assembled were prepared. In the test, each sample was pressed on a drum simulating a conventional road surface, and the tire axial force when running at a prescribed velocity was measured. Also, the actual vehicle feel was tested by a test driver.

[0189]

Comparative example

A conventional tire for sedans with a size of 185/60R14 was installed on a conventional aluminum wheel of rim size 6JJ14. The volume of the tire air chamber is about 23×10^3 cm^3.

[0190]

Application example

The tire/rim wheel assembly is of the structure shown in Embodiment 1 (see Figures 1-4), and the tire is of the same type as that in the comparative example.

[0191]

The core is composed of four core pieces with a thickness of 1 mm for the partition wall on the two ends in the circumferential direction and with a thickness of 2 mm for the remaining portion, and they are made of aluminum. The core pieces are connected when the partition walls are connected by bolts and nuts. Also, silicone oil is coated on the surface of the core.

[0192]

Also, the distance in the radial direction from the rim wheel bead sheet to the outer peripheral surface of the core (height of the core) was selected to be 58% of the radial direction distance from the rim wheel bead sheet to the inner surface of the tire tread portion.

[0193]

The total volume of the secondary air chambers in the core is about 8 L, which is about 34% of the total volume of the tire air chamber (including the tire air chamber and the secondary air chambers).

[0194]

Each core piece has four connecting holes with a diameter of 2 cm formed on the tread side. The connecting holes are set evenly on the circumference.

[0195]

In both the comparative example and application example, the internal pressure of the tire is 200 kPa.

[0196]

The test drum has a diameter of 3 m, and asphalt simulating a general road surface is bonded on it. The tire was pressed on the drum under a load of 400 kgf, and running was performed at a velocity of 60 km/h. In this case, the drum axial forces in the various directions were measured, and a frequency analysis was performed. In this test, the so-called road noise test method was adopted with vibration transferred into the vehicle.

[0197]

Figure 14(A) illustrates the results of analysis of the axial force in the upper/lower direction. Figure 14(B) illustrates the results of the analysis of the axial force in the front/rear direction of the tire.

[0198]

It was found that the cavity resonance peak near 250 Hz was significantly reduced.

[0199]

Also, using a sedan with tire/rim wheel assemblies in the application example installed on it and a sedan with tire/rim wheel assemblies in the comparative example installed on it, an actual running test was performed by two test drivers on a test course to determine steering stability and the riding comfort pertaining to vibration. /11

[0200]

In the steering stability test, an overall evaluation was performed on the drivability, braking property, steering wheel response property, and controllability when the steering wheel is turned. In the riding comfort test pertaining to vibration, an overall evaluation was performed on vibration in running on a good road, vibration in running on a poor road, vibration in running on a bumpy or another special road, and on the noise in the vehicle chamber. The evaluation results are indicated by an index with an index of 100 for the comparative example (control). The larger the index value, the better the results. The results are listed in following Table 1.

[0201]

Table 1

	1 較例	2 施例
3 操縦安定性	100	110
4 振動乗心地性	100	120

Key:
1 Comparative example
2 Application example
3 Steering stability
4 Riding comfort pertaining to vibration

[0202]

The results of the test indicate that the tire/rim wheel assembly of the application example, compared with that of the comparative example, has the same or better steering stability, and it has much better riding comfort pertaining to vibration.

[0203]

The riding comfort pertaining to vibration showed significant improvement, and, especially, a major improvement was observed for the noise inside the vehicle chamber.

[0204]

(Test Example 2)

In order to check the effect of the core, just as in Test Example 1, a sedan having tire/rim wheel assemblies of the application example installed on it and a sedan having the tire/rim wheel assemblies of the comparative example installed on it were used in performing a durability test in case of puncture when the pneumatic pressure of the right front wheel is 0.

[0205]

The sedans were run on a straight road and a mildly curved road at a velocity of 90 km/h.

[0206]

In following Table 2, the running distance when a problem occurred is listed. It can be seen that the durability was improved significantly in the application example.

[0207]

Table 2

	1 比較例	2 実施例
3 故障までの走行距離ｋｍ	１２	２００完走 4

Key:
1 Comparative example
2 Application example
3 Running distance when a problem occurred (km)
4 After completion of running for 200

[0208]

(Test Example 3)

In order to check the effect of the discontinuous configuration of the secondary air chambers in the circumferential direction, a tire/rim wheel assembly having a core of the same structure as that of the application example in Test Example 1 except that the partition walls of the application example core removed was prepared as a test sample, and the same drum test as that in Test Example 1 was performed.

[0209]

Figure 15(A) shows the results of analysis of the axial force in the up/down direction. Figure 15(B) shows the results of analysis of the axial force in the front/rear direction of the tire.

[0210]

The results of the test indicate that for the comparative example with a continuous secondary air chamber in the circumferential direction has a larger cavity resonance peak near 250 Hz, and no [noise] reducing effect is observed.

[0211]

That is, the partition walls are important in suppressing the cavity resonance sound.

[0212]

Effect of the invention

As explained above, for the core-attached rim wheel and tire/rim wheel assembly of the present invention with the aforementioned constitution, it is possible to improve the quietness and steering stability, both major qualities required for automobiles, as well as the safety in case of tire puncture without sacrifice of the riding comfort and other qualities. This is the excellent effect of the present invention.

Brief description of the figures

Figure 1 is a cross-sectional view of the main portion of the tire/rim wheel assembly in Embodiment 1 of the present invention taken across the rotating axis.

Figure 2 is an enlarged cross-sectional view of the portion of the tire/rim wheel assembly of Embodiment 1 near the rim flange on the outer side of the vehicle.

Figure 3: (A) is a side view of the core of the tire/rim wheel assembly in Embodiment 1, and (B) is a cross-sectional view taken along the equatorial plane.

Figure 4: (A)-(C) illustrate the procedure of assembly of the tire/rim wheel assembly.

Figure 5 is a cross-sectional view of the tire/rim wheel assembly in Embodiment 2 taken along the rotating axis.

Figure 6 is an enlarged cross-sectional view in the circumferential direction of the portion of core pieces of the tire/rim wheel assembly in Embodiment 2 near the end portion.

Figure 7 is a cross-sectional view of the main portion of the tire/rim wheel assembly in Embodiment 3 of the present invention taken along the rotating axis.

Figure 8 is a cross-sectional view of the main portion of the tire/rim wheel assembly in Embodiment 4 of the present invention taken along the rotating axis.

Figure 9 is a cross-sectional view of the main portion of the tire/rim wheel assembly in Embodiment 5 of the present invention taken across the rotating axis.

Figure 10: (A) is a cross-sectional view of the core of the tire/rim wheel assembly in Embodiment 6 of the present invention taken across the equatorial plane. (B) is an enlarged cross-sectional view near the end portion of the core pieces shown in Figure 10(A).

Figure 11 is an oblique view of a core piece shown in Figure 10.

Figure 12 is a cross-sectional view of the core of the tire/rim wheel assembly taken across the equatorial plane in Embodiment 6 of the present invention.

Figure 13 is a cross-sectional view of a modified example of the core of the tire/rim wheel assembly taken across the equatorial plane in Embodiment 6 of the present invention.

Figure 14: (A) shows the results of analysis of the axial force in the up/down direction of Test Example 1. (B) shows the results of analysis of the axial force in the front/rear direction of Test Example 1.

Figure 15: (A) shows the results of analysis of the axial force in the up/down direction of Test Example 3. (B) shows the results of analysis of the axial force in the front/rear direction of Test Example 3. /12

Explanation of symbols

10	Tire/rim wheel assembly
12	Rim wheel
14	Tire
14C	Tread (tire tread portion)
16	First rim wheel structural member
18	Second rim wheel structural member
26	Bead sheet portion (bead sheet)
28	Rim flange portion
42	Rim flange portion
44	Bead sheet portion (bead sheet)
52D	Wall (partition wall)
60	Secondary air chamber
62	Tire air chamber
64	Connecting hole (connecting portion)
66	Slot (rotation hindering means)
68	Elastic material layer
72	Valve
80	Vibration detecting sensor
96	Protrusion (bump, connecting means)
98	Through hole (hole, connecting means)

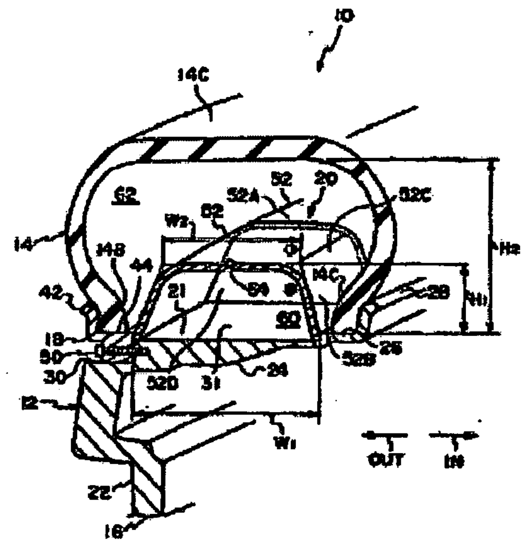

Figure 1

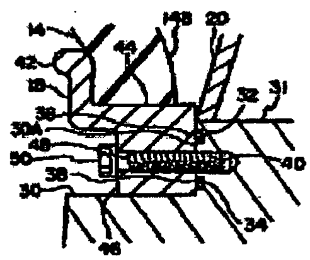

Figure 2

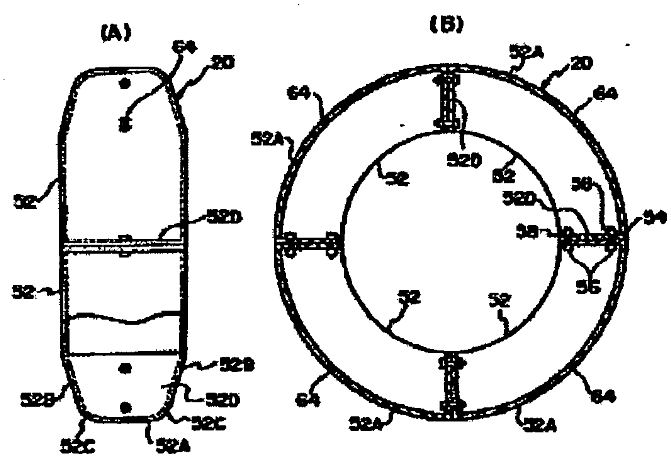

Figure 3

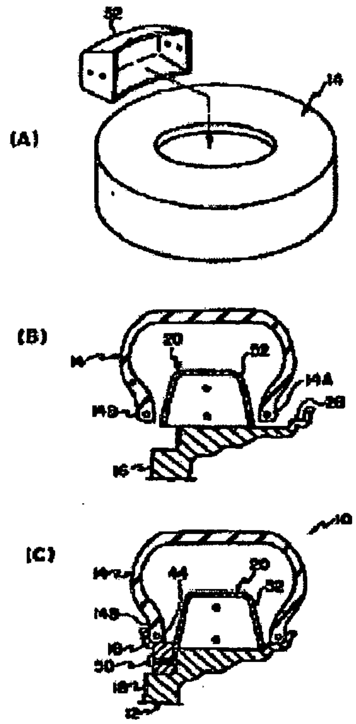

Figure 4

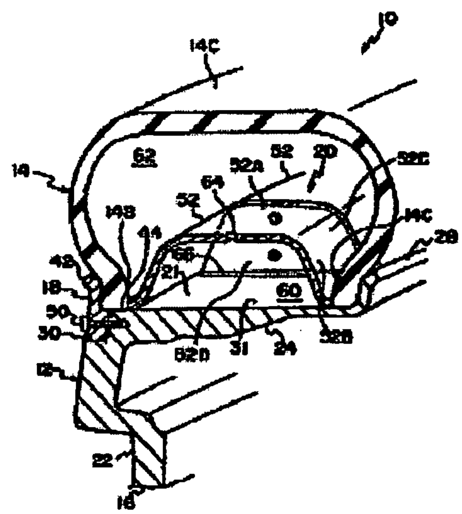

Figure 5

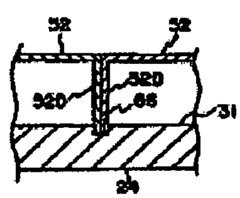

Figure 6

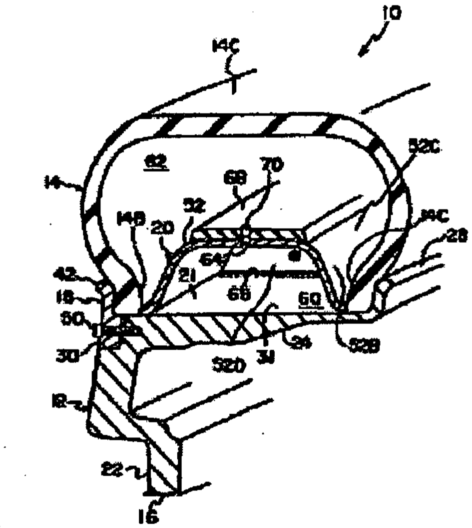

Figure 7

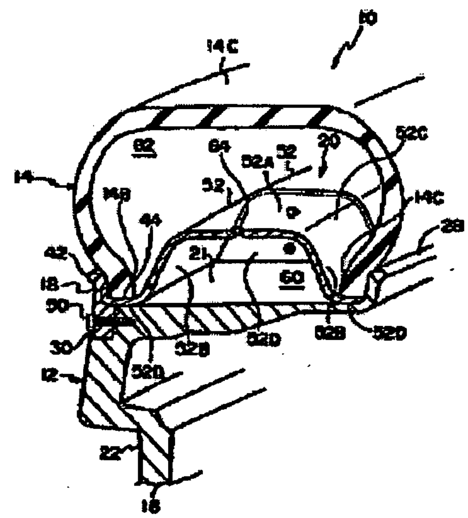

Figure 8

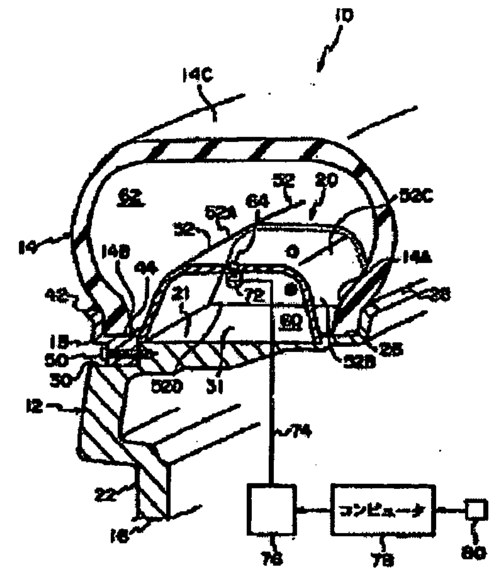

Figure 9

Key: 78 Computer

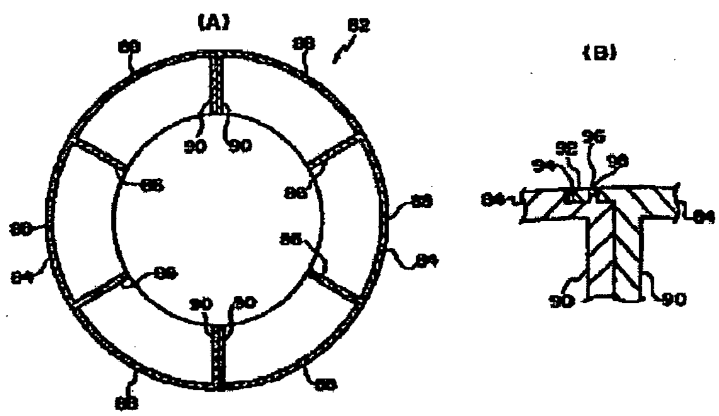

Figure 10

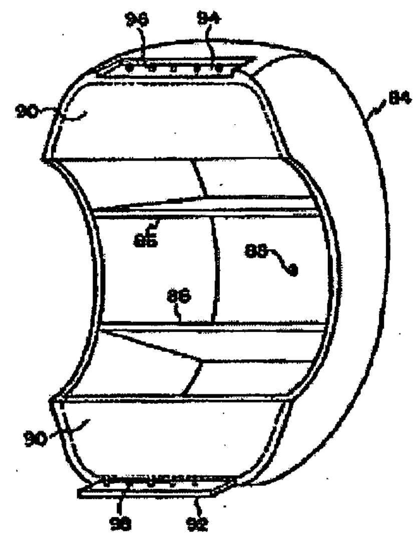

Figure 11

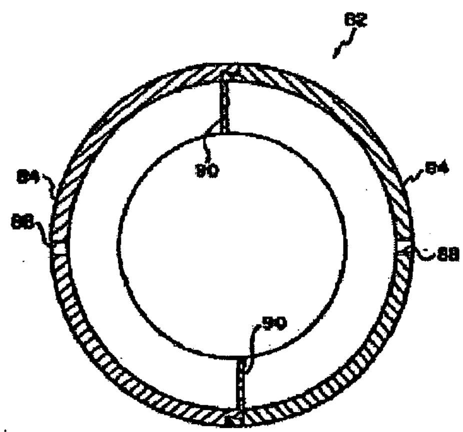

Figure 12

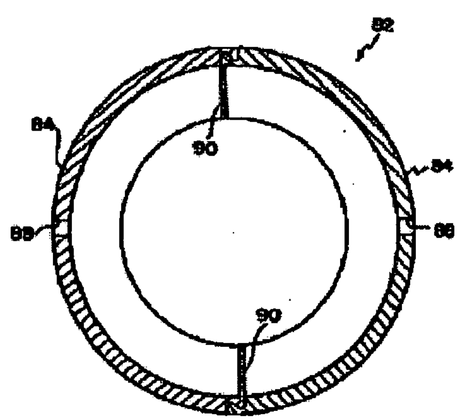

Figure 13

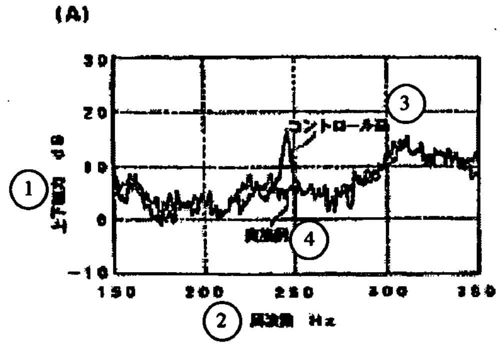

Figure 14(A)

Key: 1 Axial force in upper/lower direction
2 Frequency
3 Control sample
4 Application example

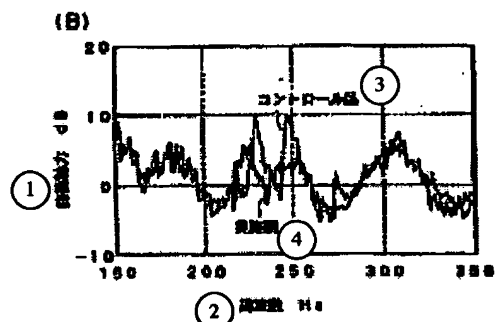

Figure 14(B)

Key: 1 Axial force in front/rear direction
2 Frequency
3 Control sample
4 Application example

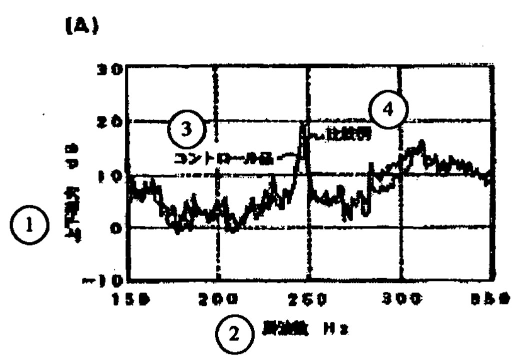

Figure 15(A)

Key: 1 Axial force in upper/lower direction

2 Frequency
3 Control sample
4 Comparative Example

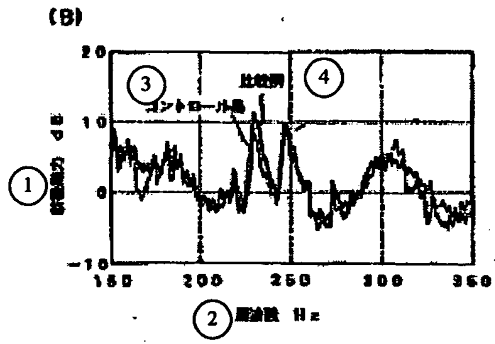

Figure 15(B)

Key: 1 Axial force in front/rear direction
2 Frequency
3 Control sample
4 Comparative example